AN UPPER CAMPANIAN VERTEBRATE FAUNA FROM THE CHESAPEAKE AND DELAWARE CANAL, DELAWARE

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Introduction

During the winter months of 1980-81 the United States Army Corps of Engineers dredged silts, clays, and sands from the bottom of the Chesapeake and Delaware Canal, Delaware, and deposited them on a large spoil area on the north bank near Reedy Point and at another north bank location one-half mile west of the town of St. Georges.

The Reedy Point deposits are composed mostly of river sands and silts dredged from the area where the canal enters the Delaware River. A fair amount of the Cretaceous Mount Laurel sands may have been mixed in, but the characteristic mega-invertebrate fauna is missing from the deposits.

The St. Georges dredge site, however, contains a rich vertebrate assemblage. This provided the author with the opportunity to collect and study a Campanian age fauna from this region, one which has not before been reported in the literature. A total of 30 genera and 36 species of vertebrates have been identified among the specimens collected. In addition there are three kinds of teleost fish teeth which are unidentified.

Shark, skate, ray, chimaera, teleost fish, turtle, and mosasaur material has been recovered. The material includes teeth, spines, vertebrae, dermal denticles, rostral spines, and body armor.

A fair number of invertebrates, used in the identification of the stratigraphic origin of the vertebrate fossils, were also recovered.

The material was collected by both surface inspection and by bulk-screening of spoil material with one-eighth and window-screen mesh screens.

Geology

The Merchantville Formation is composed of dark gray and blue, micaceous, glauconitic silt and fine sand deposited in an open marine, shallow water environment. It has been reported by Richards *et al.* (1958), Owens *et al.* (1970), and Lauginiger & Hartstein (1983) as Lower Campanian in age. Its presence at this locality is confirmed by the recovery and identification of the ammonites *Placenticeras placenta* and *Menabites delawarensis* as well as the arthropods *Hoploparia gladiator* and *Protocallianassa mortoni*. The *Protocallianassa* were found in nodules identical to those found *in situ* in the Merchantville at the "Deep Cut" locality less than one mile west of the spoils.

The Englishtown Formation is a white to pale gray sand occasionally stained brown by iron oxides. It was deposited in near shore shallow water during a slight regression or drop in sea level. It is Lower Campanian in age (Owens *et al.*, 1970) and contains numerous burrows of the arthropod *Protocallianassa* (Pickett *et al.*, 1971). The burrows in the Englishtown differ from those of other canal formations in size, surface complexity, and color. The presence of the Englishtown here is confirmed by the common occurrence of this fossil.

The Marshalltown Formation is a clayey, silty, grayish-green sand which was deposited in a shallow marine water of an embayed area during a slight rise in sea level. It is Upper Campanian in age (Owens *et al.*, 1970; Lauginiger & Hartstein, 1983) and contains the pelecypods *Exogyra ponderosa*, *Ostrea falcata*, *Trigonia* sp., *Cardium* sp., and *Cucullaea* sp. The presence of these invertebrates in fair numbers on the spoils confirms the identification of Marshalltown sediments in the spoils.

The Mosasaur, 2:141-149
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Paleontology

The vertebrate fauna is composed of 33 species of teeth, of which 20, or 60 percent, are sharks and their relatives, the skates and rays.

Partial jaw sections of the chimaera or ratfish *Ischyodus* are rare, as are the broken and rootless teeth of the hybodont sharks *Hybodus* and *Lonchidion*. In addition to the teeth, dorsal fin spines and cephalic hooks of the hybodonts have also been collected.

Teeth of the guitarfish *Rhinobatos* are very rare. The specimens were found by fine-screening the spoils.

The oral teeth and rostral spines of the ganopristine sawfish *Ischyrhiza mira* are much more common than the extremely rare rostral spines of *Ischyrhiza* cf. *avonicola* and *Sclerorhynchus*.

Rostral spines and oral teeth of *Ptychotrygon* are uncommon due to their small size. This strange fish has been linked by some scientists with the ganopristids, but at the present they remain a member of *incertae sedis* or of unknown affiliation.

The rays are represented by the isolated chevrons or pavement teeth from the primitive cownose ray *Brachyrhizodus* and the skates by isolated teeth of *Rhombodus* and *Pseudohypolophus*.

Teeth of the angel shark *Squatina* and the nurse shark *Ginglymostoma* are small and are difficult to find. Sand sharks provided the most abundant type of tooth, as represented by *Odontaspis* and *Hypotodus*.

Anterior and lateral teeth of the goblin shark *Scaphanothynchus* and the crow shark *Squalicorax* are very common.

The teeth of the primitive makeral sharks *Plicatolamna* and *Cretolamna* are of smaller sizes than are specimens found at other canal localities.

The rarest shark teeth found at this locality belong to *Pseudocorax* and the primitive thresher shark *Paranomotodon*.

In addition to teeth, vertebrae of sharks and batoids are very common and are well preserved.

The teleost or bony fish are represented by 10 species of teeth, three of which remain unidentified.

Cylindricanthus, the rostrum of a fish similar in appearance but not related to the garfish; rostral and body armor from a primitive sturgeon-like fish; body scales of *Lepisosteus*, a primitive garpike; and teleost ear stones or otoliths are also found.

Single teeth from the battery found in the upper and lower jaws of the pycnodontid *Anomoeodus* are common. Jaw fragments with multiple teeth still attached are much rarer.

Nibbling teeth of the sclerodermid fish *Stephanodus*, single teeth and partial plate pieces of the ancestral ladyfish *Paralbula*, and two teeth of the tarpon-like *Xiphactinus* have also been recovered from the sediments.

Teeth of the mosasaur *Clidastes* and the shell-crushing mosasaur *Globidens* are not common and are for the most part small and well worn.

An occasional partial plate from the soft-shelled turtle *Trionyx* and a few teeth of the small crocodile *Leidyosuchus* have also been found at the site.

Discussion

The majority of the vertebrate material was derived from sediments of the Marshalltown Formation. This conclusion is based upon the following observations:

1) The Mount Laurel Formation and its characteristic index fossils *Belemnitella americana* and *Exogyra cancellata* are not present at this locality.

2) The Englishtown Formation is present at this locality, but in Delaware this formation contains only a few invertebrates and trace fossils.

3) The Merchantville Formation does contain a vertebrate fauna, but its vertebrate fossils are usually sparse in number, large in size, and are encrusted with pyrite or siderite.

4) The Marshalltown Formation produced *in situ* vertebrate fossils of similar size, type, and mode of preservation at now-inaccessible outcrops on the south bank, east and west of St. Georges (Eugene Hartstein, personal communication).

5) The fauna of this spoil bank is consistent with an *in situ* fauna in the Wenonah Formation of New Jersey. (The fauna is undescribed and is currently under study by Hartstein and Lauginiger.) The Wenonah is not found in Delaware but corresponds in age and lithology with the upper section of the Delaware Marshalltown (Owens *et al.*, 1970, p. 19, fig. 14).

6) The fauna is similar to one which would be found in a fairly shallow open marine embayed area. It contains many bottom dwelling forms as well as fish adapted to life in fairly quiet waters. It is the same type of fauna which would have been present during the period of deposition of the Marshalltown.

7) In the dredged section, the canal cuts through the area mapped as updip Mount Laurel (Pickett, 1970) and one would expect the spoils to be from the Marshalltown Formation immediately below.

Table 1. Fossil Abundance

Fossil	Abundance[1]				
	Abundant	Common	Uncommon	Rare	Very Rare
CHONDRICHTHYES					
Ischyodus bifurcatus Case				●	
Hybodus sp.				●	
Hybodus sp., dorsal fin spine					●
Hybodus sp., cephalic hook					●
Lonchidion babulskii Cappetta & Case					●
Rhinobatos casieri Herman					●
Ischyrhiza mira Leidy			●		
Ischyrhiza cf. *avonicola* Estes					●
Sclerorhynchus sp.					●
Rhombodus levis Cappetta & Case			●		
Brachyrhizodus wichitaensis Romer			●		
Pseudohypolophus sp.			●		
Ptychotrygon vermiculata Cappetta			●		
Ptychotrygon sp., rostral denticle					●
Squatina hassei Leriche			●		
Squatina sp., dermal denticles					●
Ginglymostoma globidens Cappetta & Case				●	
Odontaspis holmdelensis Cappetta & Case	●				
Odontaspis samhammeri Cappetta & Case				●	
Hypotodus aculeatus Cappetta & Case					●
Scapanorhynchus texanus (Roemer)		●			
Plicatolamna arcuata (Woodward)			●		
Plicatolamna borodini Cappetta & Case					●
Paranomotodon angustidens (Reuss)					●
Squalicorax kaupi (Agassiz)	●				
Squalicorax pristodontus (Agassiz)			●		
Pseudocorax granti Cappetta & Case					●
Shark vertebrae	●				
Batoid vertebrae		●			
Dermal ossicles					●
OSTEICHTHYES					
Enchodus ferox Leidy	●				
Enchodus sp.				●	
Anomoeodus phaseolus (Hay)		●			
Stephanodus sp.			●		
Paralbula casei Estes			●		
Paralbula cf. sp.				●	
Xiphactinus sp.					●
Teleost tooth, type 1					●
Teleost tooth, type 2			●		
Teleost tooth, type 3					●
Lepisosteus cf. sp.				●	
Cylindrocanthus cf. sp.					●
Sturgeon scute				●	
Teleost vertebrae	●				
Teleost dorsal and pectoral fin spines	●				
Otolith					●
REPTILIA					
Clidastes cf. sp.				●	
Globidens cf. sp.					●
Leidyosuchus cf. sp.					●
Trionyx cf. sp.			●		

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[1] Abundant	more than 100 specimens collected
Common	51 to 100 specimens collected
Uncommon	26 to 50 specimens collected
Rare	11 to 25 specimens collected
Very Rare	fewer than 10 specimens collected

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Plates I and II

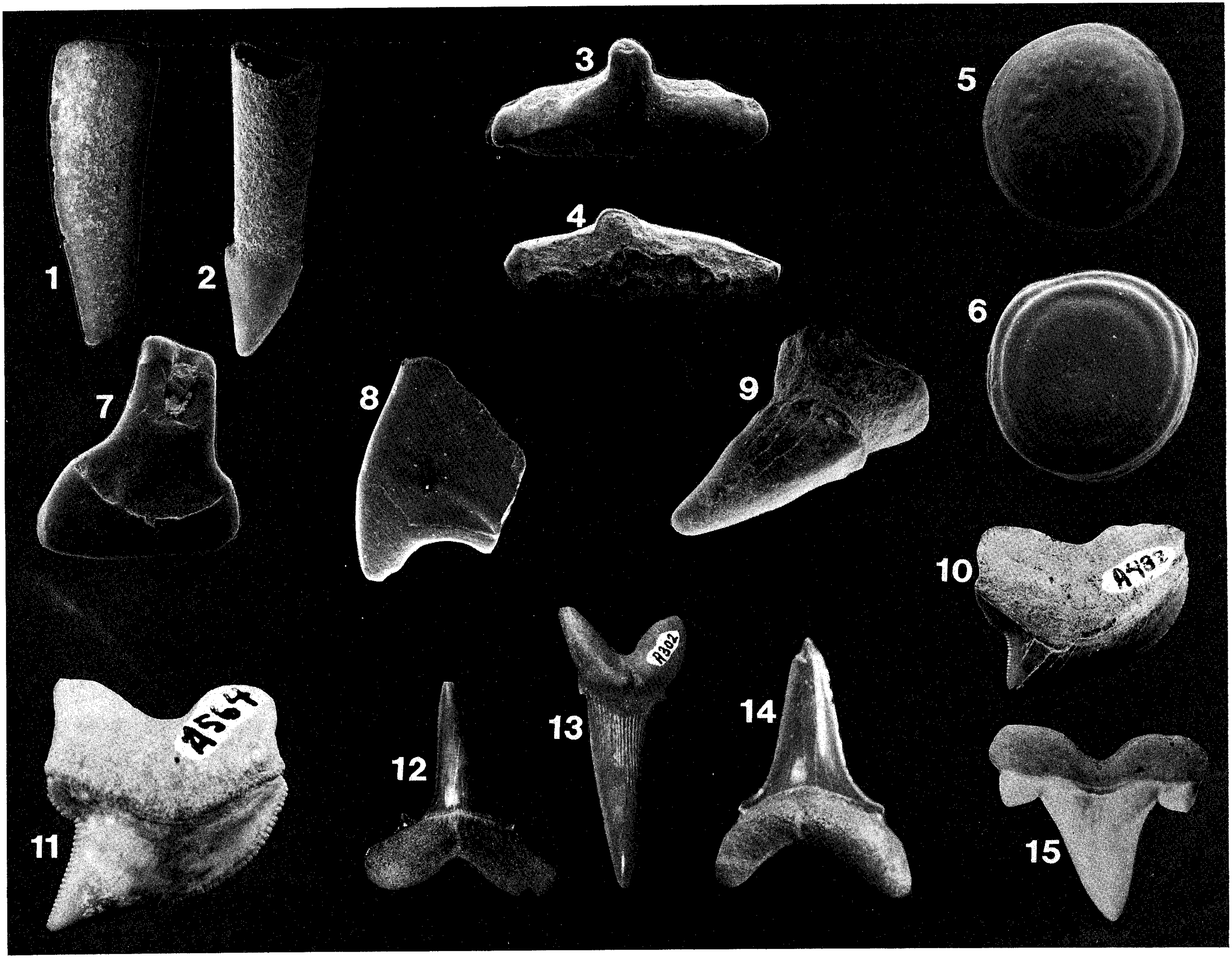
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Plate I

1. *Enchodus ferox* Leidy, lateral view; original is 5 mm in height
2. Unknown fish, Type 3, lateral view; original is 4 mm in height
3. *Lonchidion babulski* Cappetta & Case, occlusal view; original is 4 mm in width
4. *Lonchidion babulski* Cappetta & Case, basal view; original is 4 mm in width
5. *Paralbula* sp., occlusal view; original is 2 mm in diameter
6. Unknown fish, Type 2, occlusal view; original is 2 mm in diameter
7. Unknown fish, Type 1, lateral view; original is 5 mm in height
8. *Stephanodus* sp., lateral view; original is 3 mm in height
9. *Ptychotrygon vermiculata* Cappetta, rostral spine; original is 3 mm in length
10. *Squalicorax pristodontus* (Agassiz), lingual view; original is 27 mm in width
11. *Squalicorax kaupi* (Agassiz), lingual view; original is 16 mm in height
12. *Scapanorhynchus texanus* (Roemer), lingual view of a lower lateral tooth; original is 21 mm in height
13. *Scapanorhynchus texanus* (Roemer), lingual view of an anterior tooth; original is 41 mm in height
14. *Paranomotodon angustidens* (Reuss), lingual view; original is 15 mm in height
15. *Cretolamna appendiculata* (Agassiz), labial view; original is 15 mm in height

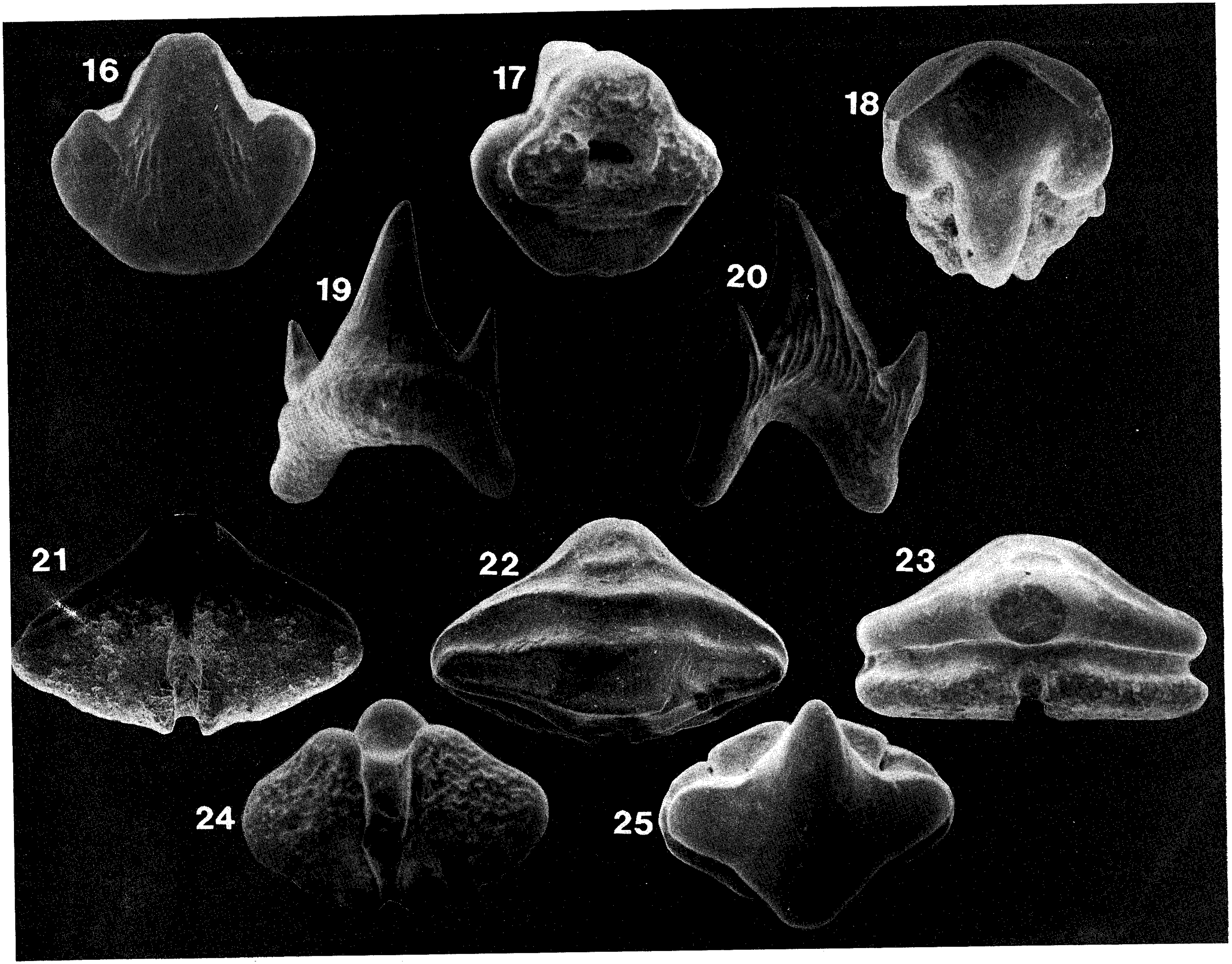
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Plate II

16. *Ginglymostoma globidens* Cappetta & Case, labial view; original is 4 mm in length

17. *Ginglymostoma globidens* Cappetta & Case, labial view; original is 4 mm in length

18. *Rhinobatos casieri* Herman, lingual view; original is 3 mm in height

19. *Plicatolamna borodini* Cappetta & Case, lingual view; original is 6 mm in height

20. *Plicatolamna borodini* Cappetta & Case, labial view; original is 6 mm in height

21. *Ptychotrygon vermiculata* Cappetta, basal view; original is 3 mm in width

22. *Ptychotrygon vermiculata* Cappetta, occlusal view; original is 3 mm in width

23. *Ptychotrygon vermiculata* Cappetta, lingual view; original is 3 mm in width

24. *Ischyrhiza mira* Leidy, basal view of an "oral" tooth; original is 5 mm in width

25. *Ischyrhiza mira* Leidy, occlusal view of an "oral" tooth; original is 5 mm in width